Space Weather Technical Forecast

Issued on Tuesday, 19 April 2022 at 13:02 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares likely throughout (R1/R2 Radio Blackouts). Active Electron Fluence likely to end current week.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours, with an M1.9 observed at GOES16 from the now-departed AR2992 in the southwest at 18/1724UTC. Not to be outdone, AR2993 also produced an M1.0 at 19/0450UTC. There are now up to five surviving front-sided sunspot regions, with the northeastern quadrant harbouring AR2993, which has produced occasional M-class activity; but also AR2994 which went through a similar phase over the UTC Easter weekend, with this region peaking with an X1.1 at 17/0331UTC. Now adding to these groups is another new region arriving, currently not accorded a number but appearing as at least a leading Hhx/Alpha.

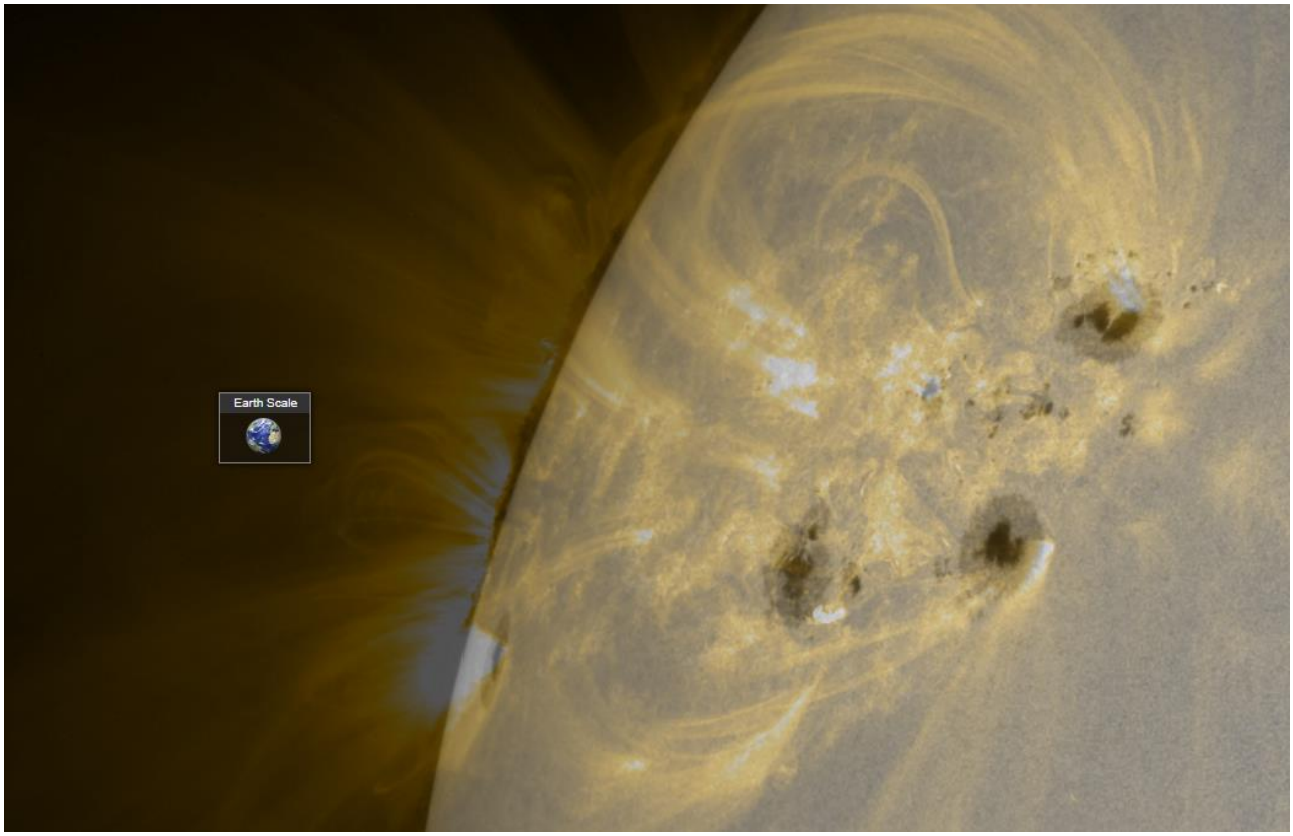

Figure 0: 19/1100UTC HMIIF and AIA 171 overlaid, showing the current active northeastern quadrant, possible upcoming regions over the limb, and the Earth to scale. Image processing courtesy of Helioviewer.org.

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AR2993 showed some changes in the period, not least a series of small sunspots encircling the northern half of its main leader, as its distant trailer decayed to reduce its span from 19 to 10 degrees, and its class from Fki to Dki/Beta-Gamma. In common with its immediate southern neighbour, some proliferation of its intermediate sunspots was also observed. AR2994 was less dynamic over the same interval, finishing the period as an Eho/Beta-Gamma. The other two sunspots on the Earth-facing side were both unremarkable: AR2991 was a stable Hsx/Alpha, while AR2990 showed a fading trend to end the 24 hours as a Bxo/Beta.

A Coronal Mass Ejection (CME) seen heading mainly westwards on morning coronagraph imagery appears to be far-sided from cursory analysis, meaning that there was no evidence of any Earth-bound CMEs in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, showed declining fast wind characteristics, with this probably emanating from CH75/+, with the phi angle accordingly mostly positive (away from the sun). The solar wind speed fell from early highs near 550km/s to reach the upper-400s of km/s by the end of the period. The solar wind density trend was a little obscure for a suspect trace, but appeared mostly within normal background below 10ppcc, while the IMF fell slightly from an early peak of 6nT. The north-south component of the field was a slightly lower +/-5nT.

The net result of the above solar wind measures was provisionally Quiet to Unsettled Kp, with a peak value of '3+' observed in the 18-21UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) measured at GOES-16 at GEO was at Background levels throughout.

The high energy electron electron flux (greater than 2MeV) showed a diurnal trend between Moderate and High flux, with a peak of 1650pfu at 18/1625UTC. The corresponding 24-hour integrated electron fluence has been below the Active threshold throughout but on a slightly rising trend, with an observed value of 5.67e7 at 19/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to be Moderate over the next four days, with a daily Slight Chance of X-class flares, mainly from the regions currently in the northeast quadrant which may be added to in the period.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs in the forecast.

The current fast wind from CH75 has now likely peaked, and the chances of G1 before midweek UTC are now very low. The high speed stream from coronal hole 76 may then connect with the Earth on 21 April, leading to a peak Slight Chance of G1/Minor Storms on day three, 21 April, with an otherwise Quiet to Unsettled background.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be at Background levels, although there is a very gradually increasing risk as the most complex regions rotate westward.

The high energy electron flux (greater than 2MeV) is likely to remain Moderate to High at first in the absence of any significant geomagnetic activity. There is then an increasing likelihood of electron fluence exceeding the Active (1e8 integrated pfu) threshold later in the period, in the wake of a coronal hole-like enhancement currently showing at STEREO A, probably the result of CH76's high speed stream.

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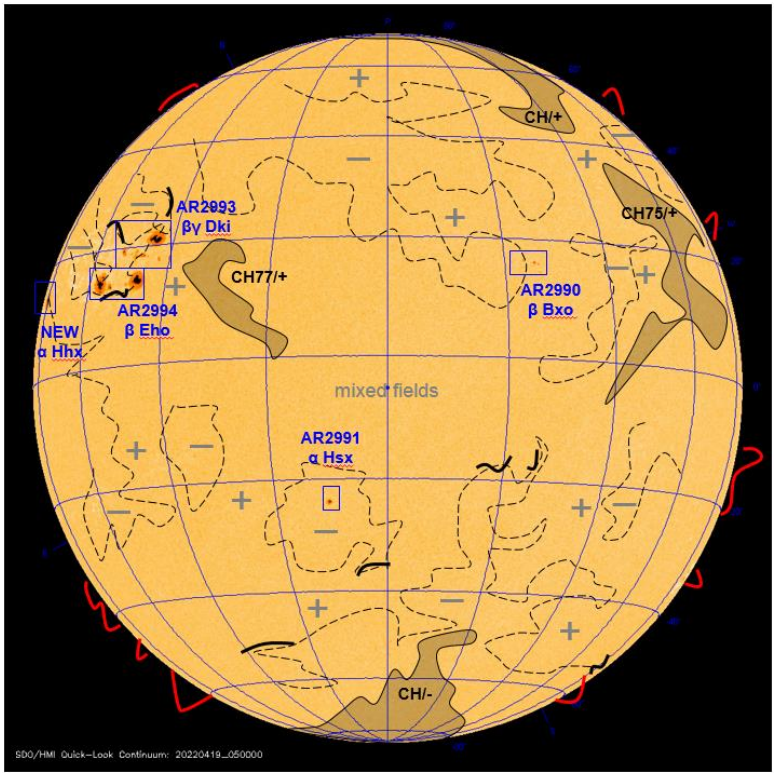
Figure 1. Solar Analysis Valid 19/0500UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There are no CMEs expected in this forecast period, although there is a small chance of minor unforecast transient features due to the sheer number of CMEs observed over recent days.

Earth is likely to undergo a gradual exit from the high speed stream from coronal hole 75 for the next 24 hours. As this is a positive hole, this feature is unlikely to significantly affect geomagnetic activity, and has likely already peaked in this respect. There is a suggestion in persistence of a second possible coronal hole high speed stream connection on day 3 (21 April), this time with coronal hole 76. This hole has become less visible over the course of the Easter weekend, to the extent that it is now very hard to discern on both AIA 211 and 193 imagery.

Despite this, there are currently signs of an upwind enhancement on STEREO A data (2.5 days upwind in the Parker sprial), with a coronal hole-like speed increase to in excess of 500km/s. The trace and evidence for this is somewhat noisy and fragmented at the time of writing, with a fuller assessment of the likely magnitude of any fast wind perhaps becoming clearer in the coming hours. If CH76 is indeed the cause, this too is a positive coronal hole, and the likelihood of significantly exceeding the Kp4 seen on last rotation is relatively slight.

All considered, geomagnetic activity is expected to be mainly Quiet to Unsettled, with a Slight Chance of Active or G1/Minor Storm intervals due to a (probable) coronal hole high speed stream on 21 April.

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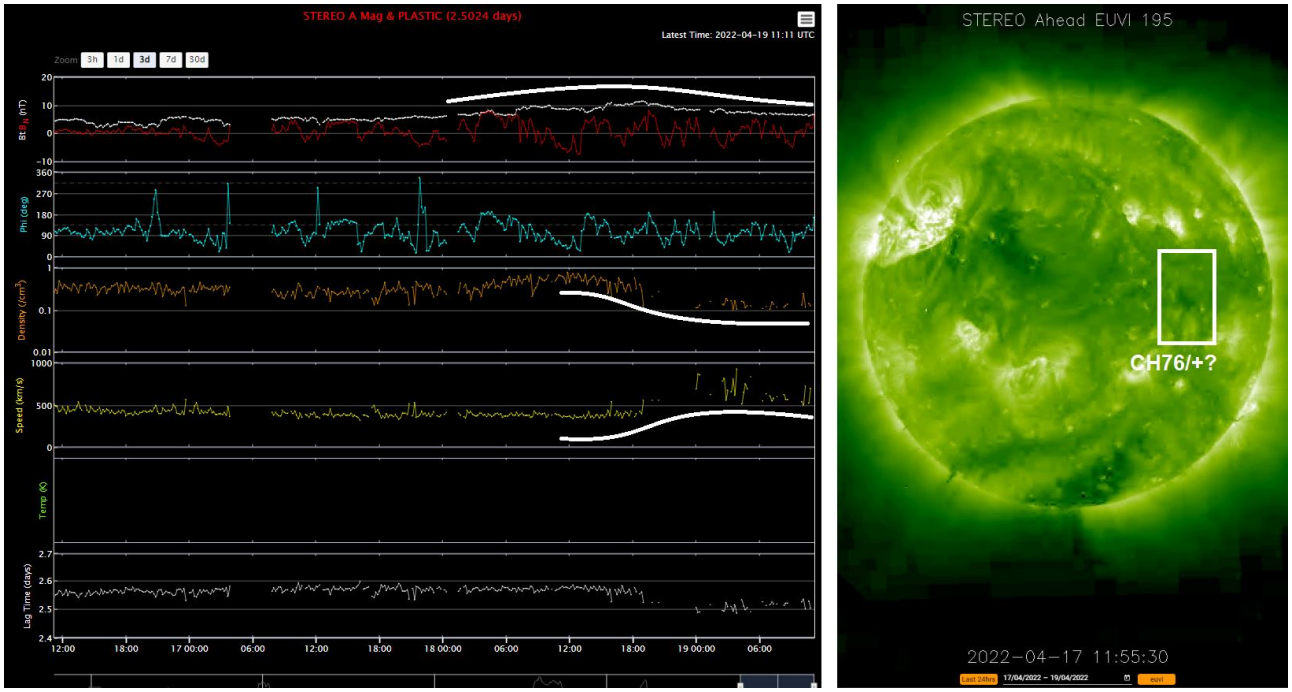
Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: Past three days STEREO A MAG and PLASTIC measurments, showing CIR into coronal hole-like signature around the expected arrival of a small and faint coronal hole, CH76/+. Also shown is EUVI 195 imagery from 48 hours ago, when CH76 was better visible from STEREO A's perspective.



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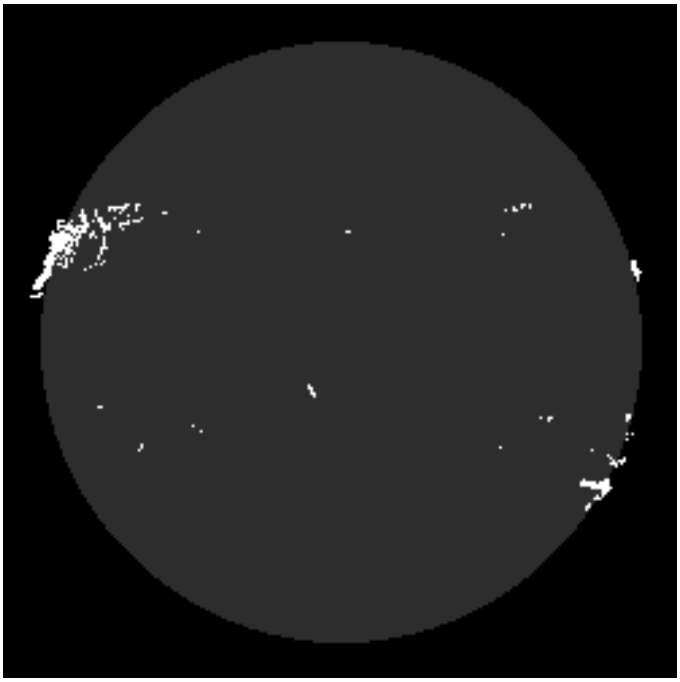
Radio Blackouts - X-Ray Flares:

The northeastern quadrant is likely to prove dominant in terms of X-ray flare risk in the period, with this area announcing its intent with an X1.1 on 17 April from AR2994, before the focus of activity shifted northwards to its immediate neighbour AR2993, with occasional M-class activity surviving here. The potency of the northeastern quadrant is likely to be reinforced in the coming 24 hours or so by further large bright flux regions visible on STEREO A EUVI 195, with the leading spot group of one of these perhaps already showing as an Hhx/Alpha.

Now that recently active AR2992 has left the Earth-facing side of the disc, no further regions are due to depart. While approaching regions over the northeast appear large, there has not been obvious recent dimming or CME activity from over the limb, and rather than increasing the probability of X-ray flares, they are therefore held constant pending proper analysis. M-class are considered Likely throughout, with a Slight Chance of X, with a probable slight upward trend after midweek TBC.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	15	15	15	15

Figure 3: Significant (C and above) X-ray flare locations from the past two weeks (courtesy of SIDC ROB). Note the strong contribution from the current northeastern limb, but also the late surge from now-departed AR2992 in the southwest.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at Background levels, and is most likely to remain so through the next four days.

The recent most active spot, AR2992 proved capable of frequent high C and low M-class activity over the past 36 hours, however there was no evidence of any accompanying solar radiation storm. There remains a slight risk from this region's presence narrowly over the western limb at first in the forecast period, however the main risk then transfers significantly eastwards to the crowded northeastern quadrant. This area too has no recent history of generating proton counts to trouble S1, however the generation of occasional M-class flares from AR2993 may start to show its hand more fully as it transits into a more favourable position to connect.

The net effect of the above is a slightly rising risk with time of S1, albeit remaining low throughout.

Radiation Storms	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ S1**	No	5	5	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux as observed by GOES-16 at GEO has been oscillating between Moderate and High levels in the recent past, and is expected to continue at this level through midweek, presuming an absence of significant geomagnetic activity.

There is an increasing likelihood of the Active threshold being breached as the period progresses, although this has again been delayed relative to recent guidance for the observed lack of response to the high speed streams of CH74 and now 75. The impetus for any rising response now lies mainly in the wake of the recent 500km/s-plus enhancement seen at STEREO A, whatever the cause (most likely some vestigial remnant of CH76), putting a step-wise increase in risk to end the current UTC working week.

MOSWOC REFM remains volatile at present, and is unlikely to be able to provide an accurate steer on electron counts given the current discrepancy between observed solar winds and those of last rotation, although this gap may lessen if CH76 has survived in some form, as appears to be the case.

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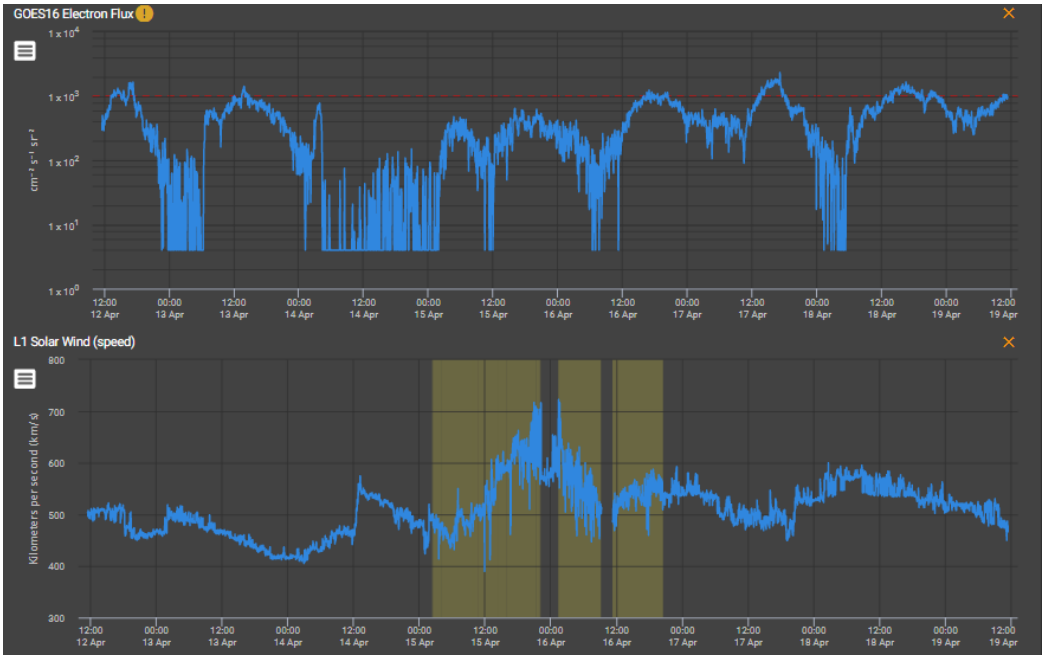
GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	20	30	40	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: The past week in GOES16 high energy electrons (top) and the causative L1 solar wind speed (bottom, mainly DSCOVR with ACE in yellow shading). The recent rising trend has stalled and the expected more sustained rise above High flux has yet to materialise, now probably not taking effect until later this coming UTC week.



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